

# CALiPER

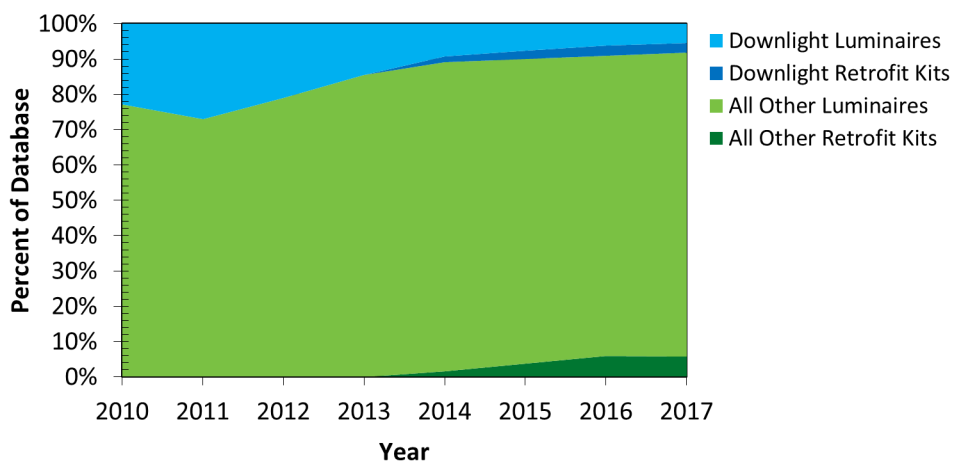
## Snapshot Downlights

Downlights are a staple of residential, hospitality, and commercial lighting, usually providing ambient illumination but sometimes focal lighting. Originally, downlights featured directional incandescent/halogen lamps—although in some cases omnidirectional lamps were used, with substantial reductions in efficiency. Later, compact fluorescent lamp (CFL) based downlights became a dominant part of the market, offering higher efficacies and longer lifetimes. However, CFL-based downlights often had low luminaire efficiency due to the omnidirectional lamp emissions, as well as some lighting quality issues.

Because of the relatively low efficiency of incumbent technologies, downlighting was among the earliest lighting applications where LEDs offered competitive performance. At their peak in 2011, downlights made up approximately 25% of the luminaires in the LED Lighting Facts® database. While the number of listed downlights has continued to increase, reaching over 4,600 today, they now represent only about 8% of the listed luminaires, as LED options in other luminaire types have steadily become available and competitive. The directional output of LEDs remains well-suited for the downlight form factor, allowing for higher efficacy and better lighting quality compared to CFLs. Now, however, the superiority of LED downlights over competing products may be limiting further performance gains, as the industry focuses on other issues, such as cost.

While the 6" aperture "recessed can" is the predominant type, the LED Lighting Facts downlight category includes a wide variety of products. This includes products with either round or rectangular apertures ranging from approximately 2"-12" in width. It includes standard integrated-LED downlights (over 3,100 products), as well as retrofit kits (over 1,500 products) that are intended for insertion into an existing housing. With output ranging from a few hundred to more than 14,000 lumens, it's clear that the products in the downlight category (encompassing both luminaires and retrofit kits) are intended for a variety of applications.

AT A GLANCE **PRODUCTS LISTED BY LED LIGHTING FACTS**



June 12, 2017

2,812 Partners

57,093 Total Active Products

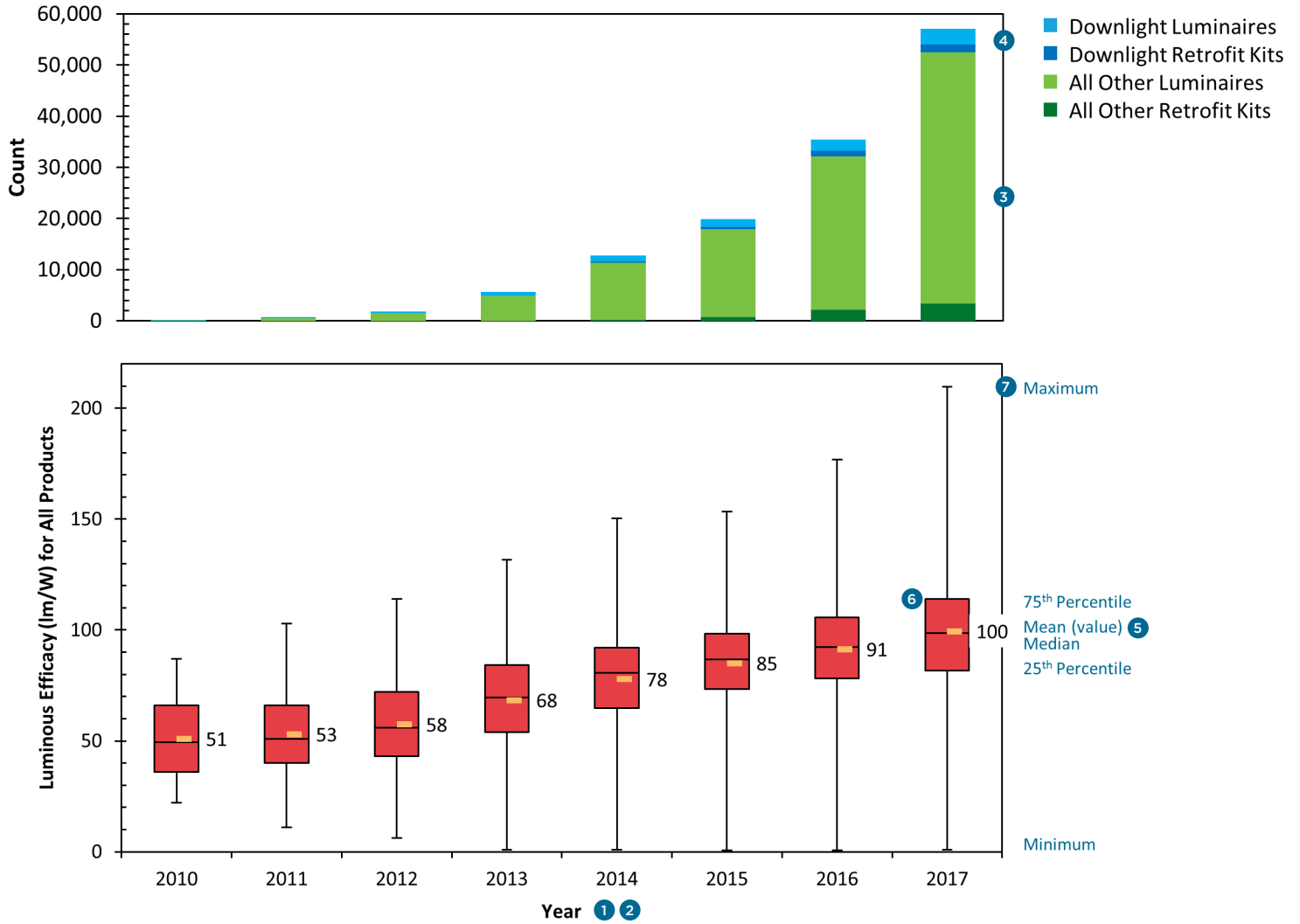
### News and Notes

- Due to changes in the market as well as in LED lamp testing requirements, LED Lighting Facts is no longer listing lamps. Previously listed lamps were removed from the database in December 2016. Luminaires and retrofit kits continue to be listed.
- Due to this change in listing status, all data for LED lamps, both current and historical, have been removed from the dataset used to generate this report. Accordingly, data for long-term trends may not exactly match previously published data.
- In February 2017, LED Lighting Facts launched a new analysis tool (Product Snapshot Analytics: <http://lightingfacts.com/Analytics>) that allows users to generate, in real time, some of the data and charts shown in this report.

### Report Highlights

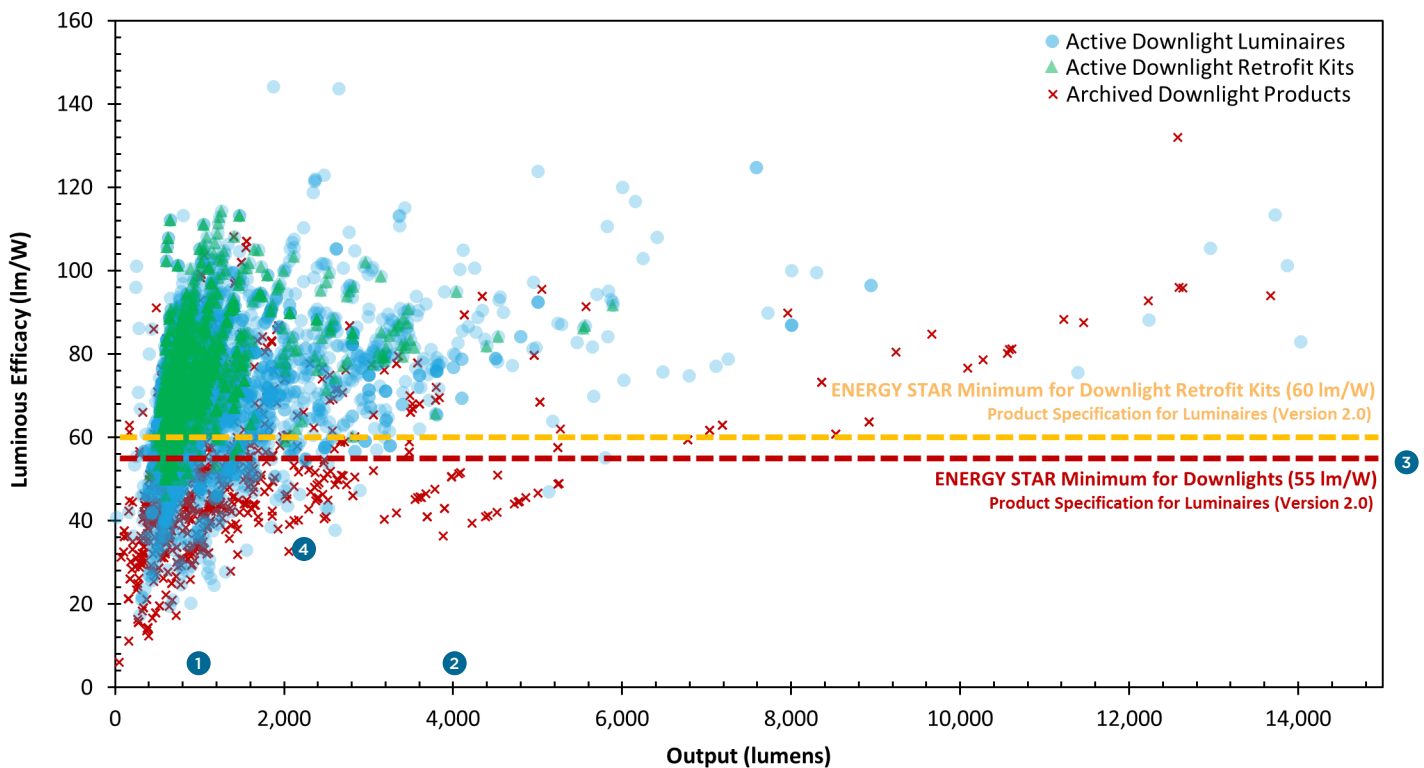
- The efficacy of LED downlights is lower than for most other product categories, although it is higher than downlights using conventional light sources. About 50% of the downlights listed have a luminous efficacy greater than 70 lm/W, with 2% above 100 lm/W.
- The mean efficacy for downlight luminaires only increased by 1 lm/W in the past 15 months, while other comparable product types gained between 5 and 13 lm/W.
- Most of the listed LED downlights fall into traditional lumen output ranges for residential and commercial applications. A wide variety of performance is available.
- The downlight category features a greater percentage of products with a CRI in the 90s than any other product category in the LED Lighting Facts database.

# All Products Listings & Efficacy Over Time



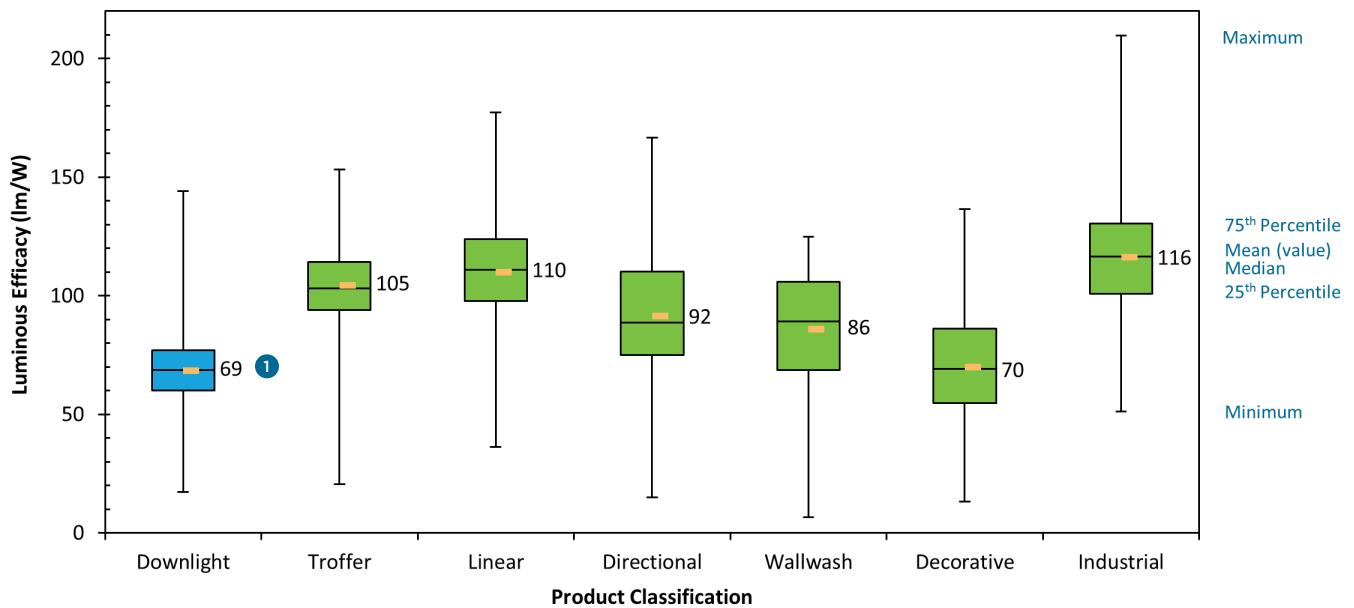
- 1 All yearly data correspond to the status of the LED Lighting Facts database in June of the listed year.
- 2 As of December 2016, lamps are no longer listed by LED Lighting Facts. This includes screw-base lamps (e.g., A lamps, PAR lamps) as well as pin-base lamps (e.g., MR16s, TLEDs). To properly display trends, all lamps have been removed from the historical dataset. This results in small changes in average and maximum efficacy values, compared to those of past CALiPER Snapshot reports.
- 3 As of June 12, 2017, there were more than 57,000 luminaires and retrofit kits listed by LED Lighting Facts. The growth in the number of listed products continues to be strong.
- 4 On the date of capture, there were 3,111 listed products classified as downlight luminaires, and an additional 1,522 retrofit kits for existing downlight fixtures. Together, this comprises approximately 8% of the total products currently listed by LED Lighting Facts.
- 5 The mean efficacy of all currently listed products is 100 lm/W, representing an increase of 9 lm/W over the past year, which is the greatest yearly gain since the period from June 2013 to June 2014.
- 6 As it has since the inception of LED Lighting Facts, the efficacy for the middle 50% of listed products covers a relatively small range (83 to 117 lm/W).
- 7 The most efficacious product currently listed by LED Lighting Facts (210 lm/W) is a high-bay luminaire. There are 648 currently listed products that exceed 150 lm/W, which was approximately the highest efficacy two years ago. These 648 products are mostly industrial fixtures but also include streetlights and troffers, as well as linear, canopy, and directional fixtures.

# Downlights Efficacy & Output



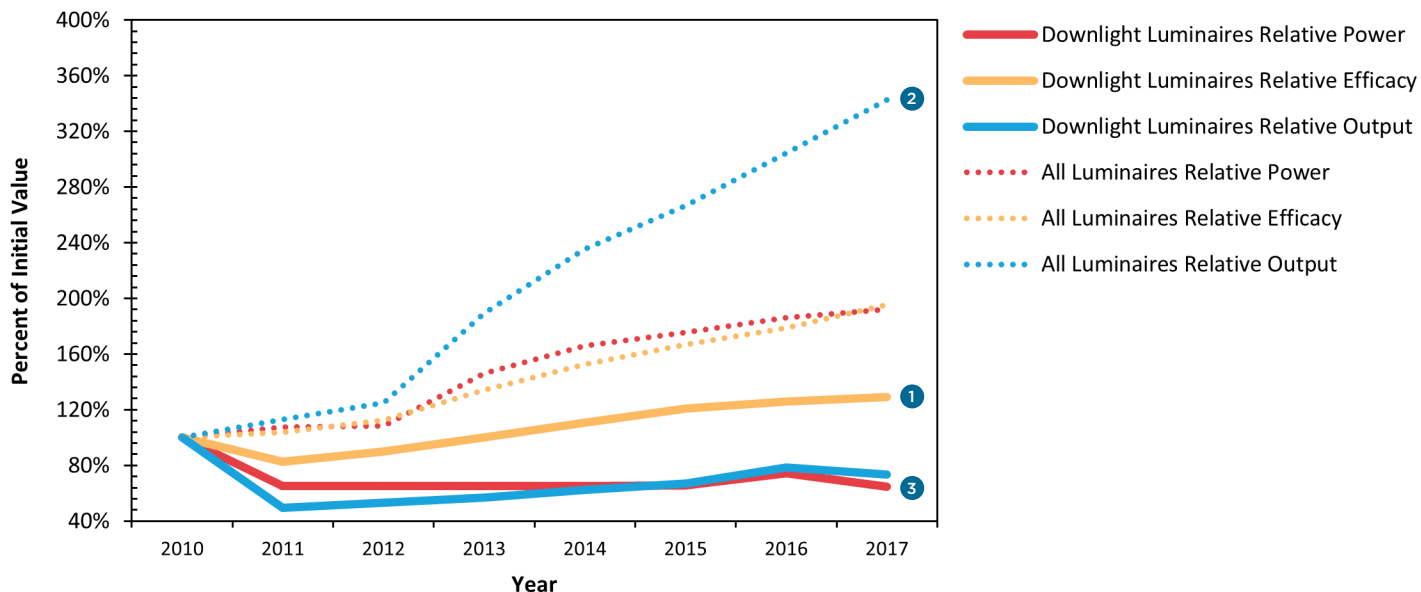
- 1 More than half of the 4,633 currently listed downlight products (including both luminaires and retrofit kits) emit between 500 and 1,000 lumens, which is most typical of a residential or hospitality application. About 35% of the currently listed downlight products emit between 1,000 and 2,500 lumens, which is more typical of a commercial application.
- 2 Eighty of the downlights currently listed by LED Lighting Facts emit more than 4,000 lumens. While still a relatively small number, this is significantly more than the 48 available in April 2016, the date of the last CALiPER Snapshot Report focused on downlights.
- 3 Since June 2016, the ENERGY STAR minimum efficacy requirements are 55 lm/W for downlights and 60 lm/W for downlight retrofit kits. About 86% of currently listed downlight luminaires, and 93% of downlight retrofit kits, meet their respective criterion.
- 4 A majority (55%) of the archived downlight products fall below 55 lm/W, which generally indicates that the lowest-performance products are the ones being discontinued.

# Downlights Current Efficacy Versus Other Luminaire Types



- 1 The mean efficacy for LED downlight luminaires currently listed by LED Lighting Facts is lower than the mean efficacies of the listed products in all other major luminaire categories except decorative fixtures. There are a number of factors that may contribute to this. The product categories where the efficacies of the incumbent technologies are highest (e.g., linear fluorescent, high-intensity discharge) all have LED products that are more efficacious than product categories where the efficacies of the incumbent technologies are lower (e.g., CFL, halogen); this includes troffer, linear, and industrial fixtures. The requirements for optical control, and other differences in form factor, likely also contribute to the differences, as do qualification thresholds for energy efficiency programs and lighting quality needs.

# Downlights Trends Versus All Luminaires

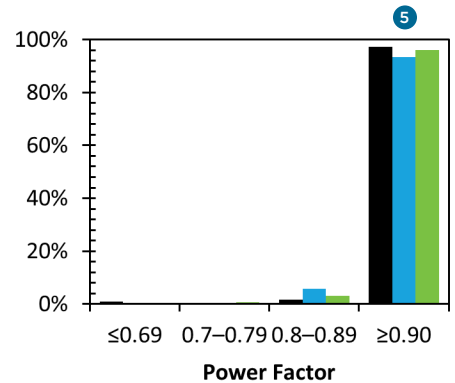
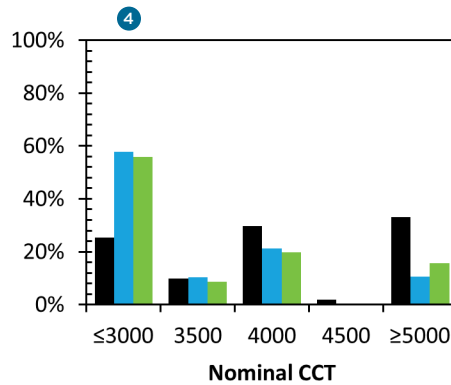
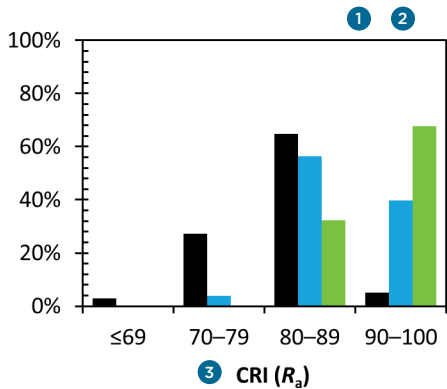
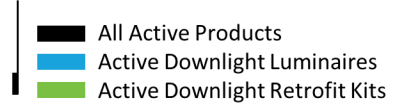
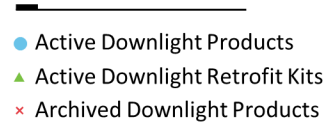
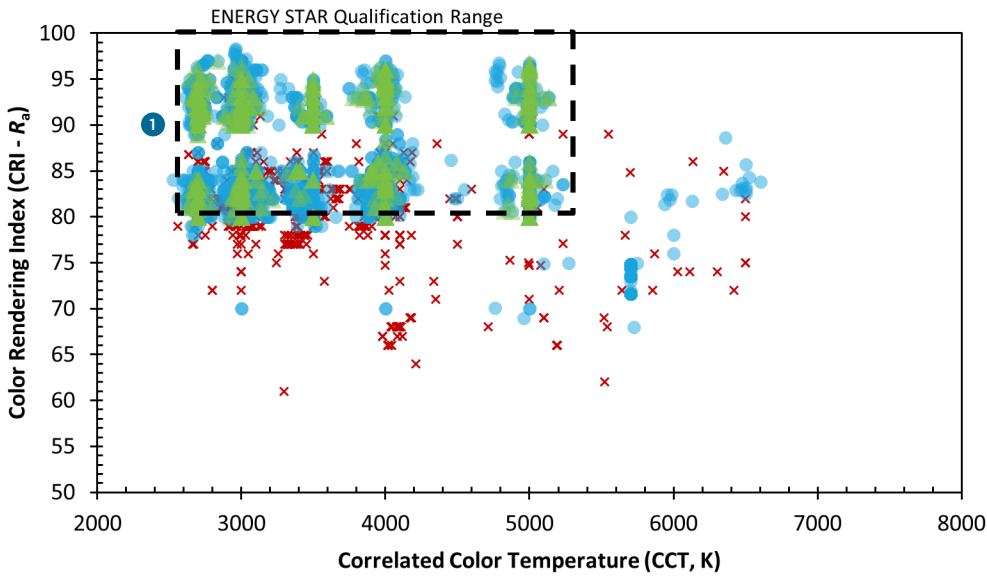


1 Since the inception of LED Lighting Facts in 2010, the 95% increase in mean efficacy for luminaires as a whole has outpaced the increase in mean efficacy for downlight luminaires (29%). This is partially due to the growth of luminaire categories, such as troffers.

2 The mean lumen output for all luminaires has increased substantially since 2010, whereas the mean lumen output for downlight luminaires has actually decreased 26%. This is principally because the output range for many downlight applications is lower (less than 2,000 lumens) than for other form factors. Commonly specified downlight lumen output ranges were achievable by LED downlights in 2010.

3 Commensurate with the changes in output and efficacy, the average power draw for LED downlight luminaires has decreased significantly (35%), whereas the average power draw for all luminaire types combined has substantially increased. Because LED downlights have long been able to meet the lumen output of conventional downlights, there has been no need to increase power draw.

# Downlights Color Quality & Power Quality



1 A vast majority (96%) of the downlight luminaires and all of the downlight retrofit kits listed by LED Lighting Facts have a CRI between 80 and 100.

2 The downlight category features a greater percentage of products with a CRI in the 90s (40% of the luminaires and 68% of the retrofit kits) than any other product category in the LED Lighting Facts database. This is likely because many of the products are intended for residential and hospitality applications.

3 IES TM-30-15 is currently an optional value for listing with LED Lighting Facts. There is not yet enough submitted TM-30 data to allow for effective comparisons.

4 A majority (57%) of the listed downlights have a nominal CCT of 3000 K or less. These CCTs are the closest to those of halogen lamps, which are often around 2800 K to 3000 K. Still, there are a substantial number of downlights (43%) that have higher CCTs, reflecting the diversity of existing downlights.

5 A vast majority (94%) of downlights that are currently listed by LED Lighting Facts (and that report this optional metric) have a power factor of 0.9 or greater. Less than 40% of all listed products report power factor.

## Discussion **LED Downlights**

The last CALiPER Snapshot on downlights was released in April 2016. In the past 15 months, LED technology has continued to progress, which is reflected in the data available through LED Lighting Facts. The number of available products is increasing, along with the mean efficacy. Today, based on photometric performance alone, there appears to be a downlight to fulfill just about every need. It's reasonable to suggest that the downlight category has reached maturity, after being one of the first market segments to see viable products that clearly beat the competition from other source types. With a current mean efficacy of 69 lm/W and products reaching as high as 144 lm/W, LED downlights are substantially more energy efficient than are halogen or CFL downlights. A large percentage of LED downlights also offer high color fidelity and good lighting quality in general—which CFL downlights usually do not deliver.

While LED downlights can be lauded for their diversity of options and superiority over legacy light sources, their performance still lags behind that of many other LED luminaire categories. Troffer, linear, directional, wallwash, and industrial luminaires all have higher mean (and maximum) efficacies—and the gap has increased in the past 15 months. The relatively low efficacy of conventional halogen and CFL downlights provides less incentive for continued efficacy gains in LED downlights, compared to luminaire types competing against relatively efficacious linear fluorescent or high-intensity discharge incumbents. Additionally, some of the discrepancy is due to different optical requirements; when additional optical materials are needed to shape the light distribution and/or reduce glare, efficiency is generally reduced. Finally, downlight minimum-efficacy criteria for ENERGY STAR qualification (55 lm/W for luminaires, 60 lm/W for retrofit kits) are substantially lower than the efficacy thresholds for other categories—which are covered under the DesignLights Consortium™ Qualified Products List, not ENERGY STAR. Because qualification criteria are typically based on currently available products, there is potential for stagnation in thresholds unless other factors influence product development.

None of this completely explains why the increase in mean efficacy for downlight luminaires over the past 15 months (1 lm/W) lags those for troffers (7 lm/W), industrial luminaires (13 lm/W), linear luminaires (10 lm/W), directional luminaires (10 lm/W), wallwashers (13 lm/W), and decorative luminaires (5 lm/w). The latter three product types are a particularly relevant comparison, with similar application demands and form factors. There are many factors that influence product efficacy, but this trend with downlights is concerning. The importance of efficacy gains is not solely related to energy savings. Improved LED package efficiency can simplify thermal management and allow more flexibility in product design, ultimately reducing product cost. With the average LED Lighting Facts-listed LED downlight at just over one-third of the DOE target for efficacy for LED luminaires (203 lm/W by 2025<sup>1</sup>), there is substantial room for continued performance gains.

<sup>1</sup> 2016 Solid-State Lighting R&D Plan, available at: [https://energy.gov/sites/prod/files/2016/06/f32/ssl\\_rd-plan\\_%20jun2016\\_2.pdf](https://energy.gov/sites/prod/files/2016/06/f32/ssl_rd-plan_%20jun2016_2.pdf)

### The Fine Print **About LED Lighting Facts Snapshot Reports**

Snapshot reports analyze the dataset—or subsets—from DOE's LED Lighting Facts product list. They are designed to help lighting distributors, designers, utilities, energy-efficiency program sponsors, and other industry stakeholders understand the current state and trajectory of the solid-state lighting market. Product classifications are at the discretion of the manufacturer, and Snapshot reports generally reflect the raw data listed in the LED Lighting Facts database. Minimal action is taken to adjust for inconsistencies.

The LED Lighting Facts database is not a statistical sample of the overall market. LED Lighting Facts is a voluntary reporting program in which manufacturers submit data for products tested in accordance with IES LM-79-08. Within any category, the data may be skewed not only by what is submitted, but also by the reporting practices of different manufacturers (e.g., reporting each small variation of a product). Given the broad nature of some of the predetermined categories, not all individual products may be directly comparable (i.e., the form factor may be substantially different). Despite these limitations, the LED Lighting Facts database is generally considered indicative of market trends. The product list includes a wide variety of product types, from manufacturers large and small, lighting industry veterans and brand new companies alike.

LED Lighting Facts and Snapshot reports focus on five core metrics: lumen output, input power, luminous efficacy, color rendering index, and correlated color temperature. Data for other performance metrics can be voluntarily submitted, and all data are available on the LED Lighting Facts website. Specifiers should thoroughly consider all aspects of performance when evaluating different products.

